THE RELATION OF THE MATHEMATICAL VOCABULARY OF THE SIXTH AND SEVENTH GRADES TO SKILL IN PROBLEM SOLVING

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THE RELATION OF THE MATHEMATICAL VOCABULARY OF THE SIXTH AND SEVENTH GRADES TO SKILL IN PROBLEM SOLVING

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CHAPTER I

INTRODUCTION

Problem

The majority of children have difficulty in solving arithmetic problems. Various educators have given their time and attention to a study of the causes of this difficulty. Some teachers have advanced the idea that a great many children have difficulty in solving arithmetic problems because they lack knowledge and understanding of the arithmetic vocabulary. Corning says:

> Since the vocabulary of problems is frequently so unknown to children as to cause serious difficulty, their knowledge of the vocabularies as found in thought problems should be tested.[1]

The purpose of this study was to make a comparison of the relative mastery of mathematical vocabulary with skills in general problem solving between two groups of sixth and seventh grade arithmetic students. An effort was made to determine to what extent knowledge of the mathematical vocabulary influenced skills in general problem solving.

Limitations of Study

The study was limited to four classes of sixth and seventh grade arithmetic students taught by the writer in

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[1]Hobart M. Corning, Review of Testing Movement, p. 25.

the Iowa Park Elementary School, Iowa Park, Texas, during the 1940-41 session.

Source of Data

Data for the study were obtained mainly from the experiment conducted with the arithmetic class. However, reputable educators and teachers were consulted in determining the relation of mathematical vocabulary to skill in problem solving.

Research on the Problem

Some investigation was made, before the experiment was undertaken, of related investigations on mathematical vocabulary. Reputable mathematical writers and teachers were consulted concerning the importance of mathematical vocabulary in problem solving, conclusions reached from various experiments, and methods used by teachers in vocabulary training in mathematics.

Setting Up the Study

The arithmetic classes of the sixth and seventh grades were divided into two groups of as near the same chronological age as possible. One hundred and twenty pupils comprised the groups, but due to withdrawals and incompletions of tests, only 107 made up the analyzed groups. At the beginning of the twelve weeks testing period, each group was given the Kulhman-Anderson Test to determine the intelligence quotients and mental ages of the pupils.

Two control groups of pupils were organized. The seventh grade was divided into A and B sections, and the sixth grade was also divided into A and B sections. All of the pupils in the four groups were then given the Kellogg-brueckner-Van Wagenen Analytical Tests. These tests were analyzed and the weaknesses of individual pupils noted. Out of these groups, four were selected for special remedial work: Group A of the seventh grade and Group B of the sixth grade. This remedial work was study in the knowledge and use of the mathematical vocabulary.

The testing period followed this selection. Group B of the seventh grade and Group A of the sixth grade were given the ordinary instruction as outlined in the Texas State Course of Study for teaching mathematics. In addition, these groups were given remedial work for the weaknesses revealed by the Kellogg-Brueckner-Van Wagenen Tests, but no special drill was given on mathematical vocabulary.

On the other hand, Group A of the seventh grade and Group B of the sixth grade were given special drill each day in the knowledge and practical use of the mathematical vocabulary in addition to their normal instruction in sixth and seventh grade arithmetic.

At the end of the twelve weeks testing period, Kellogg-Brueckner-Van Wagenen Analytical Tests were again given. The results of the tests, along with those of the first tests, were set up in tables where a comparison could be made of the results gained in the study. Analysis of the tests was made to determine the efficacy of the remedial measures, and the relation between mastery of mathematical vocabulary and skill in problem solving.

In the study of the relation of the mathematical vocabulary to skills in problem solving, various educational leaders in the field of mathematics were consulted. Special attention was given to related investigations. The tests which were used were secured from reputable educational organizations and represented those used by a great many teachers in the public schools throughout the country.

Presentation of the Data

Chapter I presented the Introduction which stated the problem, gave the source of data, outlined the manner of procedure, and gave the limits of the study.

Attention was given in Chapter II to various opinions of educational leaders regarding the extent to which a knowledge of the mathematical vocabulary influenced skills in computation. Related studies were examined and their contents noted. Suggested remedial work in mastering the mathematical vocabulary was outlined.

Chapter III dealt with an analysis of the tests given the sixth and seventh grade arithmetic pupils in the Iowa Park Elementary School, Iowa Park, Texas,at the beginning of the study. An outline was then given of the proposed remedial work for the two control groups, Group A of the seventh grade, and Group B of the sixth grade, and of the normal instruction for the other two groups, Group A of the sixth grade, and Group B of the seventh grade. This period of training was followed by the same analytical arithmetic tests given at the beginning of the testing period. The findings of these tests were discussed and analyzed.

Chapter IV presented the conclusions gained from the experiment.

CHAPTER II

SURVEY OF EDUCATIONAL LITERATURE DEALING WITH THE EFFECT OF MATHEMATICAL VOCABULARY IN PROBLEM SOLVING

The Importance of the Mathematical Vocabulary

The facility that a pupil needs in the rapid exact reading of the subject matter does not usually result from general training in reading. Training in reading subject matter of one field does not provide sufficient ability to read other types of material. Each of several fields of subject matter possesses a specific vocabulary that the reader must be able to use and understand. The type of expression and the turn of phrase of each kind of subject matter are more or less its own.

Mathematics is no exception to this rule. It has its own peculiar vocabulary, and possesses a great many terms not used in any other subject. These terms, when interpolated in arithmetic problems, may cause the student to fail in solving them if they are not properly understood. Lessinger says:

> Arithmetic computation, although seemingly farther divorced from reading than from the solution of verbal problems, does involve certain specific skills in the field of reading. In connection with an extensive study of special instruction and motivation in reading the writer has brought face to face with certain striking facts

concerning the role of reading as a factor in success in solving examples in arithmetic.[1]

Duncan gives an explanation of a mathematic vocabulary and comments on its use:

> In mathematics the vocabulary is of two types. The first is the technical vocabulary which is composed of words relating strictly to the subject. The second is a more generally functional type. It is composed of words and expressions which are mathematical in nature but which function outside the realm of mathematics. They are the words which are used to interpret mathematical concepts and appear most frequently in the verbal exercises as expressions of quanitative relationships.[2]

In arithmetic the importance of both types of vocabulary has been recognized. Stevenson asserts:

> Very often a pupil fails to solve an arithmetic problem because one or more of the words are unfamiliar. Children do not understand as much about the meaning of words as their teachers give them credit for knowing. Not only are pupils deficient in general reading vocabulary but they are also unfamiliar with the many technical words used in arithmetic.[3]

Brueckner,[4] in discussing the diagnosis of errors in arithmetic, gave as one of his conclusions: "Vocabulary exercises on important arithmetical terms and number concepts are essential." Kinney,[5] in summarizing the information that

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[1] W. E. Lessinger, "Reading Difficulties in Arithmetic," Journal of Educational Research, XI (1925), 287-291.

[2] J. D. Duncan, "The Mathematic Vocabulary," Journal of Educational Research, XX (1934), 64.

[3] P. R. Stephenson, "Difficulties in Problem Solving," Journal of Educational Research, XI (1925), 98.

[4] L. J. Brueckner, "Diagnosis in Arithmetic," Thirty-Fourth Yearbook of the National Society for the Study of Education, 1935. p. 289.

[5] L. B. Kinney, "Problem Solving and the Language of Percentage," The Journal of Business Education, X (1935), 24.

has been made available by studies in the field of problem solving, stated that "Considerable difficulty frequently results from the lack of a technical vocabulary."

The above opinions leave little doubt as to the importance of vocabulary in connection with problem solving. But it must be remembered that these are only opinions. There is a decided need for diagnosis and remedial instruction in both the technical and the problem solving vocabulary in mathematics. It still remains to be shown experimentally that instruction in the vocabulary of mathematics will improve the pupil's achievement in mathematics. During recent years unsupported opinion has been relegated to a subordinate position in Education, and the selection and organization of subject matter as well as classroom technique are increasingly based on conclusions reached as a result of scientifically conducted experiments and investigations. As one writer[6] expresses it, "Opinion is being taken down from its dusty throne and questioned and unsupported statements no longer go unchallenged." For these reasons, some attention will be given to experiments conducted by teachers in special study of the mathematics vocabulary.

Investigations of the Relation of Mathematical Vocabulary to Skills in Problem Solving

For more than a decade there has been general interest among students of the science of education in the investigation

[6] J. C. Brown, "A Summary of Some Significant Conclusions Reached by Investigators Relative to Arithmetic," Elementary School Journal, XXV (1925), 346.

of vocabulary. The general purpose of these investigations, however, has been to derive lists of important words in the various school subjects and to present standardized word lists. But of late, a different kind of study of vocabulary has been undertaken; instead of a compilation of words, vocabulary studies have attempted to study the development of children's understandings of words.

Buswell and John have made a significant study embracing the purposes of studying the development of children's understanding of words. They state the purpose of their study as follows:

> The purpose of the investigation . . . was to study the nature and the development of concepts of technical and semi-technical terms in the arithmetic of the first six grades.[7]

No attempt was made to construct a new list of standardized terms, but a study was made of the general understanding of one hundred arithmetical terms by a group of 1,500 children selected from Grades IV-VI in twelve school systems. Studies were made by way of group tests and of individual tests as well.

The evidence, as presented in the study, indicates that, as a group, the 1,500 children failed to show satisfactory understanding of technical terms which presumably they had studied. Supplementary data show that pupils may know a word presented in one situation but fail to know it when it

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[7] G. T. Buswell and Lenore John, The Vocabulary of Arithmetic, p. 3.

is presented in a different way. This fact indicates that pupils have only partial understanding of terms which they are expected to use and which appear in their textbooks.

The experimenters[8] state that the commonest criticisms of instruction in arithmetic are that the work of the pupils is formal and academic, that outside the classroom pupils fail to show true understanding of arithmetical processes, and that the meaning which the subject seems to have for them in the schoolroom fails to transfer into ordinary thinking and outside activities. These criticisms seemsto imply that too often the student memorizes a definition instead of developing it from his own experiences. Buswell and John make this significant comment:

> If pupils are to learn technical terms, the first demand on the school is that it supply a gradually increasing body of experience which will provide a meaningful background for the terms that must be learned . . .
>
> If pupils are to think clearly in arithmetic, they must have valid concepts of the terminology of the subject. The words borrow, cancel, carry, and reduce must not be associated simply with textbook definitions which can be memorized. They must be intimately associated with a background of experience of the type which gives vividness to such words as school, baseball, and Christmas. According to Webster's dictionary, a school is "a place for instruction in any branch or branches of knowledge," but what pupil could be found who would not supply from his own experience a concept far more satisfying to him in vividness and scope? If arithmetic is ever to function as more than an academic subject, pupil's concepts of its terms and its processes must become more genuine.
>
> In the process of teaching, far more intelligent attention will need to be given to the method of presenting

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[8] *Ibid.*, p. 101.

> and explaining new terms. As much study should be devoted to the means of developing a technical vocabulary in arithmetic as has heretofore been given to the development of a general vocabulary in reading.[9]

Chase[10] reports an experiment he conducted in the Fordson Public Schools to try to determine why students make mistakes in solving arithmetic problems. He was not so much concerned with the number of mistakes as he was the reasons causing the mistakes.

Chase started out with the hypothesis that the mistakes and errors which pupils are commonly observed to make, are merely symptoms and seldom, of themselves, constitute the true causes or mental maladjustments responsible for failure. He believed that future progress in the direction of corrective and preventive instruction must take into account the value and possibilities of causes of learning difficulties. His investigation was directed along these lines.

One of his findings was that lack of knowledge and understanding of the mathematical vocabulary prevented many students from achieving success in solving problems. He says:

> It is evident from this experiment, however, that lack of familiarity with combinations and processes is but one factor contributing to failure and not necessarily the most important. Other causes, such as improper reasoning habits, faulty reading and weak comprehension, were found to be responsible for much difficulty and failure.[11]

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[9] Ibid.

[10] V. E. Chase, "The Diagnosis and Treatment of Some Common Difficulties in Solving Arithmetic Problems," Journal of Educational Research, XX (1929), 335-36.

[11] Ibid.

Brueckner[12] undertook an investigation on the problem of improving instruction in arithmetic. In this study he included the psychological functions, which include:

1. Meaningful vocabulary
2. Development of clear quantitative concepts
3. Ability to read and evaluate arithmetic data.

He attempted to determine the extent to which these different classifications were related to problem solving and the extent to which they can be improved.

He found, in his investigations, that in addition to inaccuracy of computation, among the chief factors contributing to difficulty in solving conventional verbal problems were: (1) failure to comprehend the problem in whole or in part, owing to inferior reading ability; (2) carelessness in reading, resulting in misreading or the omission of essential ideas; and (3) failure to grasp the quantitative relation involved in the problem, owing to lack of knowledge of mathematical vocabulary.

During the school year, 1923-24, a study of achievement quotient technique was conducted in the public schools of Radcliffe, Iowa, under the direction of Professor Ruch and Horn of the State University of Iowa.[13] During this investigation emphasis was placed upon instruction in reading, but no variation from the typical programs for arithmetic or any other school subject was permitted. During the third

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[12] L. J. Brueckner, "Diagnosis in Arithmetic," Thirty-Fourth Yearbook of the National Society for the Study of Education, 1935, p. 289.

[13] Lessinger, op. cit., pp. 287-291.

week in September the Stanford Achievement Test, Form A was administered to all the pupils from the third to the eighth grade inclusive. At the end of the first semester, Form B of this test was given, and at the end of the second semester Form A was repeated. Since a period of eight and one-half months separated the two testings by Form A, the direct "carry-over" of familiarity on practice effects was, in all probability, negligible.

The gains in arithmetic due to the training in reading, given between the two tests, were large enough to be statistically significant, and the conclusion was reached that specific training in the reading of the instructions for the solution of examples would almost completely eliminate errors. It was found that the lack of provision in the text-books for specific training in the reading and the meaning of the mathematics vocabulary and symbols resulted in many errors.

Webb[14] conducted an experiment in the public schools of Denton, Texas, to measure the effect of the socio-economic status of sixth grade pupils on arithmetic attainment. Two hundred and twenty four pupils comprised the testing group. One phase of the experiment was the study of the extent to which the arithmetic vocabulary of the sixth grade pupils was affected by the social and economic conditions in their homes. The conclusion gained from this particular phase of the

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[14] Mary Webb, The Effect of the Socio-Economic Status of Sixth Grade Pupils on Arithmetic Attainment, (Unpublished Thesis for Master's Degree, The Department of Education, North Texas State Teachers College, August, 1938).

study was that arithmetic vocabulary of sixth grade pupils was very little influenced by social-economic environment.

Remedial Programs for Correcting Arithmetic Deficiencies

Various remedial programs for correcting deficiencies have been set forth by teachers and educators. Stevenson[13] outlined a very definite program. He said that all sane testing programs should involve the following procedure: (1) give tests; (2) locate individual differences; (3) apply remedial instruction; and (4) give tests again to see if remedial instruction is effective. He recommended the following procedure for the remedial instruction.

1. Let remedial instruction cover a period of twelve weeks.

2. Devote three fifteen minute periods each week to special remedial work, which will make a total of nine hours in the twelve weeks.

3. Divide the testing period. During the first, second, and third weeks, let the pupils read and analyze problems. Teach them to open their books to a list of problems, determine what facts are given in the problems, and the different processes necessary to solve the problem.

4. Give the students practice in the exercises upon which he fails.

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[13] R. R. Stevenson, "A Twelve-Week Remedial Program," <u>Remedial and Follow-Up Work Bulletin in Problem Solving</u>, p. 24.

5. During the fourth, fifth, and sixth weeks, let the pupils work a large variety of problems from actual life situations. Have the pupils submit problems based on some of their and their parents activities.

6. During the seventh, eighth, and ninth weeks, let the pupils solve problems without the use of numbers.

7. During the tenth and eleventh, and twelfth weeks, let the students read problems and study vocabulary. Let them state their problems in their own words, in different ways, and see that they include words with which the children have had difficulty.

8. After the twelve-week remedial work has been completed, the tests given at the beginning of the period should be repeated.

Concerning failures to solve arithmetic problems Monroe says:

> If the cause is found to be a lack of acquaintance with the meaning of words used, more attention should be given vocabulary. In the upper grades the use of the dictionary will help, but the most important thing is that the teacher shall definitely recognize the necessity for teaching the meaning of words not merely formal dictionary definitions, but rich comprehensive meanings which are directly connected with the experiences of pupils. It is frequently worth while to spend five or ten minutes in a class discussion of the meaning of important words. The use of a vocabulary test will tend to direct the attention of the teacher to the necessity of doing this. It may also happen that when the pupil finds that he is below the standard in vocabulary his cooperation will be secured.[14]

Before the experiment described in this study was undertaken, serious attention was given to the facts set forth in

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[14]Monroe, Measuring the Result of Teaching, p. 63.

this chapter. As has been noted, attention was given to the relation, if any, between knowledge of the mathematical vocabulary and skills in problem solving. Various other experiments, related in thought to the one under study, were examined. Finally, much attention was given to remedial measures recommended by teachers and educators.

CHAPTER III

ANALYSIS OF THE STUDY IN TEACHING VOCABULARY TO SELECTED GROUPS OF PUPILS IN THE IOWA PARK ELEMENTARY SCHOOL

Explanation of Study

The experiment in teaching mathematical vocabulary to a selected group of pupils was made with two arithmetic classes in the Iowa Park Elementary School, the sixth and seventh grades. These classes were composed of 107 pupils and were divided into four groups as follows: twenty-two pupils in Group B, seventh grade; twenty-nine pupils in Group A, seventh grade; twenty-seven pupils in Group B, sixth grade; and twenty-nine pupils in Group A, sixth grade. For experimental purposes, Group A of the seventh grade, and Group B of the sixth grade were singled out for special training in the study of mathematical vocabulary.

Before any special training was inaugurated, however, the entire number of pupils were given preliminary tests to determine their intelligence quotient, mental age, and ability to solve arithmetic problems of varying kinds.

Results Obtained from Kuhlman-Anderson Tests

The Kulhman-Anderson Intelligence Tests were used in this preliminary investigation. Table 1 shows the results

TABLE 1

THE INTELLIGENCE QUOTIENT, THE CHRONOLOGICAL AGE, AND THE MENTAL AGE OF THE PUPILS IN THE SIXTH GRADE, GROUP A, OF THE IOWA PARK ELEMENTARY SCHOOL, IOWA PARK, TEXAS, 1940-41

Pupil Number	IQ	Chronological Age in Years and Months	Mental Age
1	100	11-3	12-2
2	98	14-8	14-3
3	128	11-1	14-3
4	90	12-3	10-7
5	129	12-6	15-1
6	118	11-2	13-1
7	75	13-4	10-10
8	116	11-5	13-2
9	111	11-2	12-3
10	125	11-3	14-1
11	90	14-5	11-5
12	129	11-2	14-6
13	93	14-3	13-5
14	114	12-4	13-6
15	123	12-7	13-6
16	121	12-10	14-7
17	100	11-9	11-8
18	108	11-2	12-8
19	92	12-3	10-9
20	112	11-4	13-11
21	111	11-3	12-1
22	105	13-2	13-2
23	108	12-2	14-2
24	102	14-3	13-2
25	119	11-3	10-5
26	90	11-2	11-6
27	98	12-1	12-7
28	98	14-2	13-2
29	101	13-8	14-1
Mean	107	12.3	12.9

of this test with Group A of the sixth grade. Twenty-nine pupils comprised this section of the sixth grade. The mean quotient for this group was found to be 107, the range being from seventy-five to 128. This data indicates that the largest percentage of the pupils in this class were average in their intelligence quotients. According to Terman,[1] a range of 110 to 120 indicates superior intelligence; 90 to 110 indicates the normal or average; 85 to 90 indicates dullness; and below 85 deficiency begins. Fifteen pupils in this group fall into the average rating; thirteen pupils are rated as superior; and only one pupil falls below the deficiency rating.

The mean chronological age for Group A of the sixth grade was twelve and five tenth years. The mental age of the pupils did not differ materially from that of the chronological: twelve and one-half years. These data, plus that of the intelligent quotients, indicates that the class was normal in all respects and capable of doing normal classroom work of any kind ordinarily given this age group.

Table 2 gives the data on Group B, sixth grade. There were twenty-seven pupils in this group. The intelligence quotient, as revealed by the Kulhman-Anderson Test, has a range of seventy-seven to 126. Seventeen students fall into the normal or average class, ninety to 110; four students were classified as superior; and six pupils fell below ninety. The mean chronological age was 12.77 years, and

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[1]L. M. Terman, The Measurement of Intelligence, p. 79.

TABLE 2

THE INTELLIGENCE QUOTIENT, THE CHRONOLOGICAL AGE, AND THE MENTAL AGE OF THE PUPILS IN THE SIXTH GRADE, GROUP B, OF THE IOWA PARK ELEMENTARY SCHOOL, IOWA PARK, TEXAS, 1940-41

Pupil Number	IQ	Chronological Age in Years and Months	Mental Age
1	99	11-2	11-3
2	83	13-4	11-4
3	103	12-4	12-6
4	83	12-8	10-7
5	98	13-10	12-2
6	90	11-8	11-5
7	119	11-9	13-6
8	109	14-2	12-8
9	112	13-3	13-3
10	95	12-6	13-3
11	106	14-4	13-2
12	107	12-3	12-1
13	90	13-6	10-2
14	88	12-5	12-3
15	103	14-3	12-5
16	122	14-2	12-6
17	101	12-5	12-4
18	103	15-7	11-5
19	101	11-1	11-6
20	96	11-2	12-3
21	126	11-10	11-8
22	77	12-2	11-10
23	85	12-3	10-1
24	103	12-2	12-9
25	85	12-4	13-3
26	100	14-5	12-5
27	92	12-1	12-8
Mean	99	12.77	12.72

the mean mental age, 11.75. These data indicate a wider spread of intellectual ability in this group than that of the A division of the same grade.

TABLE 3

THE INTELLIGENCE QUOTIENT, THE CHRONOLOGICAL AGE, AND THE MENTAL AGE OF THE PUPILS IN THE SEVENTH GRADE, GROUP A, OF THE IOWA PARK ELEMENTARY SCHOOL, IOWA PARK, TEXAS, 1940-41

Pupil Number	IQ	Chronological Age in Years and Months	Mental Age
1	103	12-2	13-2
2	113	12-4	14-6
3	132	12-3	15-8
4	114	13-9	14-6
5	124	12-1	15-3
6	106	12-2	13-2
7	121	15-6	14-6
8	115	12-7	12-1
9	120	12-5	15-8
10	127	12-3	15-6
11	109	13-2	14-7
12	116	13-6	14-6
13	103	13-2	13-1
14	91	16-1	14-2
15	89	13-4	11-3
16	84	14-10	12-4
17	110	12-6	13-6
18	109	13-5	13-2
19	111	13-6	14-1
20	103	12-6	13-2
21	124	13-5	12-3
22	116	12-4	14-2
23	110	12-8	14-3
24	111	12-7	13-4
25	109	13-1	15-6
26	102	12-2	12-8
27	118	12-11	12-2
28	77	12-8	12-3
29	100	15-1	13-5
Mean	109	13.1	13.4

Table 3 gives the data for Group A of the seventh grade. There were twenty-nine pupils in this group. The intelligence quotient had a range from seventy-seven to 132. Sixteen pupils had an intelligence quotient of 110 or more, which indicates that a large percentage of this group were of superior intelligence. Ten pupils had a range from ninety to 110, and only three pupils could be classified as dull.

The mean chronological age for this group was 13.1; the mean mental age was 13.40. All data indicate a group of children capable of doing excellent work.

Table 4 gives the data for Group B of the seventh grade. There were twenty-two pupils in this group. Of these, eight were above the normal or average intelligence quotient; thirteen had a range of ninety to 110; and one fell into the group below ninety. The mean intelligence quotient for the entire class was 105.5. The mean chronological age was 13.1, and the mean mental age was 13.90.

The above data indicate that the two grades, as a whole, were normal or about the average in intelligence. Group A of the sixth grade had an intelligence quotient of 107; Group B's intelligence quotient was ninety-nine. The average for the two groups was 103. The seventh grade with intelligence quotients of 109 and 105.5, respectively, had an average of 107.25 for both groups. In regard to age, in

TABLE 4

THE INTELLIGENCE QUOTIENT? THE CHRONOLOGICAL AGE, AND THE MENTAL AGE OF THE PUPILS IN THE SEVENTH GRADE, GROUP B, OF THE IOWA PARK ELEMENTARY SCHOOL, IOWA PARK, TEXAS, 1940-41

Pupil Number	IQ	Chronological Age in Years and Months	Mental Age
1	98	13-1	11-5
2	121	12-9	13-8
3	102	12-8	13-6
4	116	12-2	15-8
5	118	12-7	12-1
6	96	13-8	12-2
7	94	14-1	13-3
8	85	15-3	13-4
9	104	13-2	13-6
10	92	13-2	12-7
11	103	12-6	12-2
12	98	13-5	12-2
13	112	13-6	13-9
14	103	12-2	13-1
15	114	12-2	13-2
16	116	15-1	12-3
17	109	13-4	12-4
18	121	13-6	15-6
19	113	12-7	12-7
20	106	14-8	12-3
21	102	12-5	12-4
22	99	12-7	12-2
Mean	105.5	13.1	13.0

both the sixth and seventh grades, the mean mental age was slightly lower than the mean chronological age.

Two groups were selected from these four groups for an experiment in teaching mathematical vocabulary and to determine, if possible, its relation to the pupil's ability to solve ordinary arithmetic problems. Group A of the seventh grade and Group B of the sixth grade were chosen as the control groups. Group A of the sixth grade and Group B of the seventh grade were to be given ordinary instruction, without any special stress being placed on vocabulary.

Results Obtained from Analytical Tests Given at Beginning of Term

The first step in the study was to give a standard arithmetic test to all the students. A number of standard tests were studied, and the Analytical Scales of Attainment for arithmetic developed by Brueckner, Kellogg and Van Wagenen was chosen to give the students. These tests are standard and are approved by reputable educators, and it was felt they would give some indication of the pupil's skill in problem solving in many different kinds of arithmetic operations.

Exactly the same test was given to the four groups of the sixth and seventh grades. After the tests were taken by the students, the data obtained was tabulated and analyzed.

Table 5 gives the data for Group A of the sixth grade. In quantitative relationships the mean C score was 73.75; in arithmetic problems, the mean C score was 82.81; in arithmetic vocabulary, the mean C score was 76.07, and in fundamental operations the mean score was 75.43.

TABLE 5

THE C SCORES OF QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING, ARITHMETIC VOCABULARY AND FUNDAMENTAL OPERATIONS OF THE SIXTH GRADE, GROUP A, ARITHMETIC CLASS AT BEGINNING OF STUDY

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	73	80	73	68.5
2	71	71	73.5	67
3	83	83.5	101	85,5
4	52	89	70	72.5
5	83	91	81	77.5
6	76.5	83.5	89	81.5
7	41	80	70	80
8	74.5	72.5	81	72.5
9	83	89	89	83.5
10	86.5	93	82.5	85.5
11	69.5	89	66.5	59.5
12	74.5	89	79.5	70.5
13	78.5	83.5	75.5	81.5
14	52	80	79.5	81.5
15	87.5	81.5	94.5	76
16	78.5	85	87.5	76
17	67.5	83.5	54.5	81.5
18	78.5	76	81	63
19	67.5	87	82.5	76
20	78.5	89	84	77.5
21	73	76	81	77.5
22	85	65	54.5	81.5
23	74.5	85	75	79.5
24	69.5	87	87.5	67
25	61	93	81	61.5
26	90.5	72.5	54.5	77.5
27	86	71	61	77.5
28	73.5	87	63	67
29	65	87	63	81.5
Mean	73.76	82.81	76	75.43

Table 6 presents the results of the analytical tests given the sixth grade arithmetic class, group B, at the beginning of the study. In quantitative relationships, the mean C score was 69.85; in solving arithmetic problems, the mean C score was 76.44; in arithmetic vocabulary, it was 68.73; and in fundamental operations, it was 66.71.

Table 7 presents the data obtained from the analytical tests given the seventh grade arithmetic class, group A, at the beginning of the study. In quantitative relationships, the mean C score was 82.23; in problem solving, the mean C score was 90.92; in arithmetic vocabulary, the mean C score was 88.76; and in fundamental operations, the mean C score was 76.98.

Table 8 presents the data obtained from the analytical tests given the seventh grade arithmetic class, group B, at the beginning of the study. In quantitative relationships, the mean C score was 77.5; in problem solving, the mean C score was 79.81; in arithmetic vocabulary, the mean C score was 77.25; and in fundamental operations, the mean C score was 75.15.

After these tests were graded and analyzed, the weaknesses of the children in different operations was noted. These differences varied with the classes, but it was observed that the lowest mean C scores were found in quantitative relationships and in fundamental operations.

TABLE 6

THE C SCORES OF QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING ARITHMETIC VOCABULARY AND FUNDAMENTAL OPERATIONS OF THE SIXTH GRADE, GROUP B, ARITHMETIC CLASS AT THE BEGINNING OF THE STUDY

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	67.5	71	65	54.5
2	61	71	34	70.5
3	67	72	65	72
4	41	67	45.5	61.5
5	73	65	66.5	59.5
6	52	83.5	79.5	67
7	81.5	81.5	81	74
8	76.5	80	73.5	74
9	69.5	110	78	87.5
10	65	65	58.5	61.5
11	67.5	74.5	81	70.5
12	61	89	63	70.5
13	87.5	83.5	50.5	54.5
14	52	80	90.5	77.5
15	74.5	59	63	68.5
16	80	67	61	68.5
17	41	83.5	63	48.5
18	74.5	91	68	68.5
19	41	91	63	68.5
20	65	95	72	74
21	71.5	67	78	77.5
22	73	76	96.5	72.5
23	87.5	56	61	63.5
24	52	76	65	57.5
25	65	78	70	61.5
26	69.5	65	78	59.5
27	87.5	78	87.5	77.5
28	52	65	65	48.5
2				
Mean	69.85	76.44	68.73	66.71

TABLE 7

THE C SCORES IN QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING ARITHMETIC VOCABULARY, AND FUNDAMENTAL OPERATIONS OF THE SEVENTH GRADE, GROUP A, ARITHMETIC CLASS AT BEGINNING OF STUDY

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	77.5	91.5	75	75
2	93	97	91	95.5
3	83	91.5	80	86
4	75	81	85	75
5	93	101	99.5	82.5
6	88.5	90	82	77
7	71	77	80	78.5
8	84.5	84.5	104.5	82.5
9	75	101	92.5	80.5
10	91.5	105	111	82.5
11	83	91.5	76.5	67.5
12	79.5	88	89.5	77
13	84.5	77	100.5	68
14	90	105	78	75
15	51	91.5	97.5	69.5
16	86.5	93.5	94	91.5
17	79.5	91.5	88	84
18	88	88	94	69.5
19	94.5	77	86.5	91.5
20	62	105	69.5	77
21	91.5	91.5	83.5	82.5
22	71	77	94	75
23	83	103	73	64.5
24	93	91.5	93.5	75
25	84.5	90	90.5	69.5
26	81.5	97	94	69,5
27	90	86	73	64.5
28	77.5	82.5	90.5	69.5
Mean	82.23	90.92	88.76	76.98

TABLE 8

THE C SCORES IN QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING, ARITHMETIC VOCABULARY, AND FUNDAMENTAL OPERATIONS OF THE SEVENTH GRADE, GROUP B, ARITHMETIC CLASS AT BEGINNING OF STUDY

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	80	65	70.5	60
2	81.5	84.5	82.5	75
3	75	82.5	71	78.5
4	77.5	86	85	87.5
5	75	88	60.5	89.5
6	71	79	78	73.5
7	81.5	77	80	67.5
8	75	72	64.5	69.5
9	88.5	81	78	64.5
10	86.5	86	83.5	77
11	75	75	71	91.5
12	75	82.5	85	69.5
13	77.5	84.5	82	73.5
14	79.5	84.5	76.5	77
15	75	72	71	73.5
16	77.5	82.5	68.5	69.5
17	75	82.5	92.5	73.5
18	81.5	86	80	91.5
19	51	77	76.5	71.5
20	90	84.5	91	75
21	75	66	75	73.5
22	81.5	77	77	71.5
Mean	77.5	79.81	77.25	75.15

With these weaknesses in mind, the study for the two non-control groups was planned for the next twelve weeks. The Course of Study recommended by the Texas State Department of Education for the teaching of arithmetic in the sixth and seventh grades was closely followed. No special effort was made to teach any special skill except in seeking to remedy the weaknesses the tests had revealed.

On the other hand, the two control groups, A of the seventh grade, and group B of the sixth grade, were given special attention in the study of mathematical terms. The course of study was the same as that of the two non-control groups, the lesson time of the class was the same, and no particular time was set aside for vocabulary drill. The extra work was brought in with the regular class work without any extra attention being called to it, and without the pupil's knowledge that the vocabulary study had any special meaning.

In determining the number and kind of words to be used for drill, a great deal of thought and attention was given to what is meant by mathematical vocabulary. There are any number of technical terms used in arithmetic not commonly used in the adopted arithmetic texts and in everyday life. It was felt that there was no special need for burdening the children with terms of this kind. Thorndike's list of mathematical terms was not specific enough nor of sufficient length. Buswell and John[1] had made a detailed study of the

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[1] G. T. Buswell, and Lenore John, The Vocabulary of Arithmetic, Appendix A, pp. 107-116.

vocabulary of arithmetic and had set up a list of five hundred terms commonly used in arithmetic. After much study, it was decided to use these five hundred terms for use in the control groups of the classes under study. This list of words is attached to the study in the Appendix.

Drill in Mathematical Vocabulary

With this list of words as basic training material, the study with the control groups of the sixth and seventh grade arithmetic classes was begun. No definite period was set aside each day for study of these words. An effort was made to present the words as part of the regular instruction of the class and in as natural a manner as possible.

Mere drill on the words was not resorted to in the study. Knowledge of the word, how to spell it, and what it meant was not considered sufficient. Actual experience with the use of the words was sought wherever possible. For example, the word <u>acre</u> was illustrated by actually measuring an acre of land. A square foot was compared with a running foot by measuring the two and showing the difference; a square inch was likewise compared with an ordinary inch measurement. Such words as <u>terminate</u>, <u>solution</u>, <u>result</u>, <u>volume</u>, <u>vertical</u>, <u>quantity</u>, <u>operation</u>, <u>parallel</u>, <u>partial</u>, <u>installment</u>, <u>expenditure</u>, and many others were put in concrete terms and illustrated through familiar experiences of the children. Drill was used only to refresh the children's knowledge of words they had learned through their own experiences, and was never used for merely memorizing words. As near as possible the mathematical vocabulary listed in the Appendix was incorporated into the daily lives and experiences of the children.

Results of Analytical Tests Given
At End of Study

At the end of twelve weeks the identical tests given the four groups at the beginning of the term were again given.

Table 9 presents the data obtained from the analytical test given Group A of the sixth grade, a non-control group which had been given ordinary instruction with no particular stress placed on mastering a mathematical vocabulary. In quantitative relationships, the mean C score was 82.01; in problem solving the mean C score was 88.49; in arithmetic vocabulary, the mean C score was 87.01; and in fundamental operations, the mean C score was 83.62.

Table 10 presents the data obtained from the results of the test given to Group B, the control group of the sixth grade. In quantitative relationships, the mean C score was 79.33; the mean C score for problem solving was 84.12; the mean C score for arithmetic vocabulary was 89.46; and in fundamental operations, the mean C score was 76.25.

Table 11 presents the data obtained from the analytical test given Group A of the sixth grade, a control group, after the completion of instruction featuring special study in mathematical vocabulary. In quantitative relationships, the mean C score

TABLE 9

THE C SCORES IN QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING, ARITHMETIC VOCABULARY, AND FUNDAMENTAL OPERATIONS OF THE SIXTH GRADE, GROUP A AFTER NORMAL INSTRUCTION OF TWELVE WEEKS

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	65	81.5	76.5	74
2	73	72	75	80
3	88	75	78	80
4	87.5	91	94.5	77.5
5	81.5	91	84	82.5
6	86	87	90.5	83.5
7	78.5	91	85.5	76
8	41	61	54	73
9	74.5	85	89	81.5
10	86	95	108.5	95.5
11	80	85	89	81.5
12	94	101	87.5	68.5
13	71.5	91	73.5	82.5
14	76	89	81	85
15	78.5	81.5	78	71.5
16	80	89	85.5	73.5
17	95.5	97.5	101	72.5
18	81.5	76	96.5	74
19	87.5	83.5	70	72.5
20	87.5	93	81	84
21	80	91	84	72.5
22	71.5	89	87.5	84
23	81.5	70	85.5	79.5
24	80	81	85.5	75
25	69.5	89	70	79.5
26	69.5	72	81	75
27	71.5	72.5	90.5	79.5
28	78	85	89	65
29	84	87	72	76
Mean	82.01	88.49	87.01	83.62

TABLE 10

THE C SCORES IN QUANTITATIVE RELATIONSHIPS PROBLEM SOLVING, ARITHMETIC VOCABULARY? AND FUNDAMENTAL OPERATIONS OF THE SIXTH GRADE, GROUP B, AFTER PERIOD OF SPECIAL INSTRUCTION IN VOCABULARY

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	70	83	85	80
2	67	85	85.5	70.5
3	75.5	83	90	80
4	57	71	75	72.5
5	74.5	76	82.5	74.5
6	84.5	87	94.5	73.5
7	64.5	91	94.5	77.5
8	74.5	85	94.5	76
9	76.5	95	89	85.5
10	85	78	90.5	76
11	80	74	87	66.5
12	73	83.5	87.5	77.5
13	74	82	96.5	87
14	97	97.5	86	77.5
15	76	98	96.5	84
16	86	92	86	86
17	96	76.5	96.5	94
18	71.8	80	98	74
19	87.5	78	97	70.5
20	66	79	89.5	82
21	105	75	89	77.5
22	90.5	101	81	81.5
23	73.5	86	80	78.5
24	69.5	72.5	99	73.5
25	74	87	113.5	78.5
26	69.5	93	90	79.5
27	93.5	80	84	74
28	88.5	86.5	70	87
Mean	79.33	84.12	89.46	76.25

TABLE 11

THE C SCORES IN QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING, ARITHMETIC VOCABULARY, AND FUNDAMENTAL OPERATIONS OF THE SEVENTH GRADE, GROUP A, AFTER PERIOD OF SPECIAL INSTRUCTION IN VOCABULARY

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1	84.5	86	108.5	84
2	94.5	103	104	82.5
3	93	102.5	106.5	91.5
4	84.5	81	114	80.5
5	102	103	123.5	86
6	103	88	90	86
7	84.5	88	88	71.5
8	89	88	108	99.5
9	83	101	123.5	75
10	100.5	101	114	78.5
11	84.5	99	88	76
12	100.5	95	111	77.5
13	85	96	99	76.5
14	80	92	100	83
15	88.5	105	118.5	86
16	87	93.5	123.5	82.5
17	94.5	99	128.5	84
18	91.5	97	104.5	75
19	91.5	103	111	82.5
20	86.5	93.5	123.5	89.5
21	91.5	95	123.5	73.5
22	84.5	107.5	128.5	82.5
23	88.5	97	108.5	77.5
24	85	86	99	73.5
25	91.5	99	114	80.5
26	97	94	98	80
27	102	99	103	89
28	88.5	77	100.5	78.5
Mean	90.58	95.28	109.37	81.52

TABLE 12

,THE C SCORES IN QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING, ARITHMETIC VOCABULARY, AND FUNDAMENTAL OPERATIONS OF THE SEVENTH GRADE, GROUP B, AFTER A PERIOD OF NORMAL INSTRUCTION

Pupil Number	C Scores			
	Quan. Rel.	Prob.	Arith. Vocab.	Fund. Op.
1				
2	86.5	77	86.5	74.5
3	90	90	94	82.5
4	77.5	88	80	83.5
5	86.5	105	89.5	86
6	71	91.5	81.5	89.5
7	90	86	88.5	81.5
8	67	93.5	86	88.5
9	75	84	89.5	76
10	90	84	85	79.5
11	83	91.5	89.5	85
12	90	91.5	85	89.5
13	67	97	89.5	85
14	88.5	81	85	73.5
15	77.5	91.5	83.5	75
16	84.5	77	75	83.5
17	77.5	81	79.5	75
18	90	84	79.5	89.5
19	77.5	97	86.5	71.5
20	79.5	66	93.5	76.5
21	71	88	69.5	93.5
22	81.5	75	76.5	88.5
Mean	77.31	82.7	80.31	83.52

was 90.58; in problem solving, the mean C score was 95.28; in arithmetic vocabulary, the mean C score was 107.37; and in fundamental operations, the mean C score was 81.52.

Table 12 presents the data obtained from the analytical test given Group B, the non-control group of the seventh grade, after a period of normal instruction with no special stress placed on vocabulary. In quantitative relationships, the mean C score was 77.31; in problem solving the mean C score was 82.7; in arithmetic vocabulary, the mean C score was 80.31; and in fundamental operations, the mean C score was 83.52.

After these tests were all completed, it was possible to compare the results and determine the efficacy, if any, of the special instruction given the two control groups in the study of mathematical vocabulary. Table 13 presents the mean C scores of all the groups at the beginning of the study and at the end of twelve weeks.

When these mean C scores of the different groups were analyzed and tabulated, it was found that Group A, of the sixth grade, the non-control group, had gained 8.25 points in quantitative relationships, 5.68 points in problem solving, 11.01 points in mathematical vocabulary, and 5.08 points in fundamental operations. Group B of the sixth grade, the control group, had gained 9.48 points in quantitative relationships, 7.68 points in problem solving, 20.75 points in arithmatic vocabulary, and 9.54 points in fundamental operations.

TABLE 13

THE MEAN C SCORES IN QUANTITATIVE RELATIONSHIPS, PROBLEM SOLVING, ARITHMETIC VOCABULARY, AND FUNDAMENTAL OPERATIONS OF GROUPS A AND B OF THE SIXTH AND SEVENTH GRADE ARITHMETIC CLASSES AT THE BEGINNING OF THE STUDY AND AFTER A PERIOD OF TWELVE WEEKS

Group	Grade	Test	Mean C Scores			
			Quan. Rel.	Prob. Solv.	Arith. Vocab.	Fund. Op.
A	6	1	73.76	82.81	76	75.43
A	6	2	82.01	88.49	87.01	80.51
B	6	1	69.85	76.44	68.73	66.71
B	6	2	79.33	84.12	89.46	76.25
A	7	1	82.83	90.92	88.76	76.98
A	7	2	90.58	95.28	109.37	81.52
B	7	1	77.5	79.81	77.25	75.15
B	7	2	77.31	82.7	80.31	83.52

Group A of the seventh grade, the control group, gained 9.75 points in quantitative relationships, gained 4.36 points in problem solving, 20.61 points in arithmetic vocabulary, and 4.54 points in fundamental operations.

Group B of the seventh grade, the non-control group lost 0.19 points in quantitative relationships, gained 2.89 points in problem solving, 3.06 points in arithmetic vocabulary, and 8.37 points in fundamental operations.

These data show that the control groups, in both instances, made substantial gains in almost all operations over those of the non-control groups, and made outstanding gains in arithmetic vocabulary. The conclusion is reached that special instruction in vocabulary of arithmetic aids the pupil in all arithmetic operations.

CONCLUSIONS

The following conclusions were drawn from this study:

1. The control group in the sixth grade which was given special vocabulary drill gained 1.23 more points in tive relationships, 2.00 points more in problem solving, 9.74 more points in arithmetic vocabulary, and 4.46 more points in fundamental operations than the non-control group. This indicates that the special drill given Group B, the control group, was beneficial to the pupils in aiding them in all forms of arithmetic operations.

2. Group B of the sixth grade, the control group, was lower in its mean intelligence quotient than Group A; this indicates that the control group benefited even more than the non-control because it made more gains in spite of the lower intelligence quotient.

3. The control group in the seventh grade, Group A, made 9.94 more points in quantitative relationships, 1.47 more points in problem solving, 17.55 more points in arithmetic vocabulary, and 3.83 more points in fundamental operations, than the non-control group. The conclusion is reached that the special drill given the control group aided them in all arithmetic operations.

4. Group A of the seventh grade, the control group, had a higher mean average intelligent quotient than Group B, the

non-control group. In this instance the group with the highest intelligence quotient made the most gains.

5. The study shows that the special drill aided the children more in quantitative relationships and arithmetic vocabulary than it did in problem solving and fundamental operations. The least gain made was in fundamental operations.

6. Each of the control groups made outstanding gains in arithmetic vocabulary. This shows that the drill did have a beneficial effect on the children, and that they did not learn the mathematical vocabulary of themselves and without help as well as those with special instruction.

7. The reaction of the writer to the study is this:

A. She believes that the special vocabulary drill was of much help to the children in all arithmetic operations.

B. The favorable results, in her opinion, justified the extra time and attention needed to carry on the study.

C. She recommends special vocabulary drill to all teachers who wish to aid their children master more easily the operations involved in solving arithmetic problems.

APPENDIX

FIVE HUNDRED TERMS COMMONLY USED IN ARITHMETIC

about
above
account
accumulate
accuracy
accurate
acre
add
addend
addition
additive
after
again
aliquot
all
allowance
almost
already
also
altitude
always
among
amount
and
angle
annex
annual
another
answer
any
apiece
approximate
area
arithmetic
around
at
average
away
back
backward
balance
barrel
base
before
begin
below
beneath
besides
between
beyond
big
bill
block
borrow
both
bought
breadth
bushel
but
buy
calculate
calculation
cancel
cancellation
capacity
carry
cash
cent
center
century
change
charge
cheap
check
circle
circular
circumference
clear
coin
collect
column
combination
combine
commercial
commission
common
compensation
computation
compute
cone
consecutive
contain
cord
correct
corresponding
cost
count
couple
credit
cube
cubic
date
day
debit
debt
decade
decimal
decrease
deduct
deep
degree
denominate
denomination
denominator
deposit
depth
diameter
difference
digit
dime
dimensions
diminish
discount
distance
distant
divide
dividend
divisibility
division
divisor
dollar
double
down
downward
dozen
due
during
each
early
earn
earnings
either
empty
end
enlarge
enough
entire
equal
equality
equation
equilateral
equivalent
estimate
even
ever
every
exact
example
exceed
except
excess
exclude
exercise
expenditure
expense
expensive
express
extend
extra
fact
factor
far
fare
farther
fast
fee
feet
few
fifth
figure
fill
final
first
following

foot
form
former
forward
fraction
frequently
from
full
further
gain
gallon
gill
graph
great
gross
group
half
halves
heavy
height
high
hogshead
horizontal
hour
hundredweight
improper
in
inaccuracy
inaccurate
inch
include
inclusive
income
incorrect
increase
inside
installment
integer
interest
into
invert
invest
investment
just
large
last
late
latter
least
left
length
less
light
like
limit
line
linear
little
loan
long
loss
lot
low
make
many
maximum
measure
measurement
middle
mile
mileage
mill
minimum
minuend
minus
minute
money
month
more
most
much
multiple
multiplicand
multiplication
multiplier
multiply
narrow
near
net
never
next
nickel
no
none
nothing
now
number
numeral
numeration
numerator
numerical
oblong
occasionally
odd
of
often
omit
on
once
only
operation
order
other
ounce
out
outside
over
owe
own
paid
pair
parallel
part
partial
past
pay
payable
payment
peck
penny
per
percentage
perimeter
piece
pint
plus
point
portion
pounds
precede
prefix
present
previous
price
prime
principal
problem
proceeds
process
product
profit
profitable
prompt
proof
proper
prove
purchase
quadrilateral
quantity
quart
quarter
quire
quotient
radius
rate
ratio
ream
receipts
reciprocal
rectangle
rectangular
reduce
reduction
remain
remainder
remit
rent
repeat
respectively
rest
result
retail
return
rod
round
row
salary
sale
save
savings
score
season
second
section
sell
series
several
share
short
sign
since
single
size
small
smaller
sold
solution
solve

some
sometimes
space
spend
spent
square
straight
subtract
subtraction
subtrahend
successive
sufficient
sum
surface
table
take
tall
term
terminate
then
there
thick
thickness
third
time
times
together
ton
took
total
toward
triangle
triangular
twice
under
unequal

unit
unlike
up
upon
upper
upward
usually
valuable
value
vertical
volume
wages
week
weight
whole
wholesale
wide
width
with
without
worth
yard
year
−
—
/
−
⟌
=
$
%
altogether
Arabic number
at the rate of
common denominator

count by twos
cubic foot
cubic inch
cubic yard
decimal point
denominate number
greatest common divisor
hundreds' column
improper fraction
least common multiple
long division
lowest common denominator
lowest terms
mixed number
per cent
per yard (foot, etc.)
proper fraction
reasonable answer
Roman number
short division
square foot
square inch
square mile
square rod
square yard
take away
tens' column
thousandths' column
total amount
trial quotient
unit fraction
unit of measure
units' column
what part of
whole number

BIBLIOGRAPHY

Brown, J. C., "A Summary of Some Significant Conclusions Reached by Investigators Relative to Arithmetic", Elementary School Journal, XXV (1925), 346.

Brueckner, Leo, J., "Diagnosis in Arithmetic," Thirty-Fourth Yearbook of the National Society for the Study of Education, 1935, p.289.

Brueckner, L. J. Diagnostic and Remedial Teaching in Arithmetic, Philadelphia, John C. Winston Company, 1930.

Buswell, G. T. and Judd, C. H., "Summary of Educational Investigations Relating to Arithmetic," Supplementary Educational Monographs, No.27, Chicago Department of Education, University of Chicago. 1925. pp.3-4.

Corning, Hobart M., Review of Testing Movement, New York, Ginn and Company, 1938.

Chase, V. E., "The Diagnosis and Treatment of Some Common Difficulties in Solving Arithmetic Problems," Journal of Educational Research, XX (1929), 335-36.

Duncan, J. D., "The Mathematic Vocabulary", Journal of Educational Research, XX (1934), 64.

Gorman, F. H., "Arithmetic Vocabulary of the Elementary School Teacher", Elementary School Journal, XXXVIII (1938), 373.

Kinney, L. B., "Problem Solving and the Language of Percentage", The Journal of Business Education, X (1935), 24.

Lessenger, N. E. "Reading Difficulties in Arithmetical Computation," Journal of Educational Research, XI (1925)

Morton, R. L., Teaching Arithmetic in Intermediate Grades, New York, Silver Burdett & Company., 1927. p.32.

Stevenson, P. R., "Difficulties in Problem Solving", Journal of Educational Research, XI (1925), 98.

Stevenson, R. R., "A Twelve-Week Remedial Program", Remedial and Follow-Up Work Bulletin in Problem Solving. Bloomington, Illinois, Public School Publishing Company, 1932.

Taylor, D. M., "Arithmetical Vocabulary," _Instructor_, XLIV (1934), 44.

Terman, L. M., _The Measurement of Intelligence_, New York, MacMillan and Company, 1932.